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## Maternal Health Behaviours During Pregnancy in an Irish Obstetric Population and Their Associations with Socio-Demographic and Infant Characteristics

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## ORIGINAL ARTICLE

# Maternal health behaviours during pregnancy in an Irish obstetric population and their associations with socio-demographic and infant characteristics

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**Background/Objectives:** To examine the prevalence and combined occurrence of peri-conceptional folic acid (FA) supplement use, smoking and alcohol consumption during pregnancy in a sample of women in Dublin, and determine the factors associated with these health behaviours.

**Subjects/Methods:** A prospective observational study (2004–2006) involving the recruitment of 491 pregnant women from antenatal clinics in a Dublin maternity hospital, with postpartum follow-up of 450 eligible mothers. Data on FA use, maternal smoking and alcohol consumption patterns during pregnancy were collected from the antenatal patient-administered questionnaire, which was completed by participants, and returned to the investigator on the day of recruitment.

**Results:** The median gestational age of women at recruitment was 36 weeks. A combined 24.2% of mothers commenced FA at the recommended time, avoided alcohol consumption and smoking during pregnancy. In all, 35.3% of mothers reported to consuming alcohol, 20.9% smoked during pregnancy and 44.4% commenced FA at the recommended time. Mothers <25 years were more likely to have not taken FA at the recommended time (adjusted odds ratio (aOR): 4.0, 95% confidence interval (CI): 1.64–9.77) and were more likely to have smoked during pregnancy (aOR: 3.56, 95% CI: 1.32–9.57). Irish nationality positively predicted both alcohol consumption (aOR: 4.37, 95% CI: 1.88–10.15) and smoking (aOR: 10.92, 95% CI: 1.35–87.98) during pregnancy.

**Conclusions:** Educational efforts are still necessary to convince women of Irish nationality, in particular, of the adverse effects of smoking and alcohol consumption on fetal outcome. Women <25 years should be specifically targeted in smoking cessation and FA promotional campaigns.

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**Keywords:** maternal health; pregnancy; cigarette smoking; alcohol consumption; folic acid; prenatal care

## Introduction

Optimal pregnancy and infant health outcomes are associated with non-smoking (Kramer, 2003) and absolute maternal avoidance of alcohol consumption (World Health Organisation, 2006) during pregnancy, in addition to compliance with peri-conceptional folic acid (FA) supplementation (Kirke *et al.*, 1992). Maternal cigarette smoking during pregnancy is associated with increased risks for

placenta previa (Monica and Lilja, 1995) and abruption (Pollack *et al.*, 2000), intrauterine growth retardation (Horta *et al.*, 1997), preterm delivery (Kyrklund-Blomberg and Cnattingius, 1998) and sudden infant death syndrome (Wisborg *et al.*, 2000). Prenatal alcohol exposure is a known preventable cause of birth defects (Krulwich, 2005), and Fetal Alcohol Syndrome, the leading cause of mental retardation worldwide and the foremost preventable cause of neurobehavioral and developmental abnormalities (Banakar *et al.*, 2009). To avoid these adverse risks, policy in Ireland recommends non-smoking (Health Service Executive, 2008) and absolute abstinence from alcohol both during pregnancy and among women wishing to conceive (Department of Health and Children, 2008).

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Furthermore, it is universally accepted that maternal compliance with peri-conceptional FA supplementation can substantially decrease the risk of congenital malformations (Wilcox *et al.*, 2007), as well as the incidence (Czeizel and Dudas, 1992) and recurrence (MRC, 1991) of neural tube defects (NTDs), including spina bifida, anencephaly and encephalocele. However, the potential for preventing NTDs in Europe by increasing folate status is far from being achieved (Busby *et al.*, 2005). Department of Health, Republic of Ireland (1992) recommends that women who could possibly become pregnant should consume a daily 400 µg FA supplement 3 months before conception and during the first 12 weeks of pregnancy, in addition to folate-rich foods. Compliance with this recommendation is particularly important for women in Ireland, as Irish NTD rates are among the highest in Europe (Food Safety Authority of Ireland, 2006).

In spite of these concerns, only limited research has quantified the prevalence and predictive factors of these health behaviours among women in Ireland. Such research is critical to enable policymakers and clinicians design targeted interventions and effective preventative strategies, especially in high-risk populations. The present study, thus, aimed to examine the prevalence and combined occurrence of peri-conceptional FA supplement use, smoking and alcohol consumption during pregnancy in a sample of women in Dublin, and to determine the factors associated with these health behaviours.

## Methods

### *Study population and design*

Details of the study methods and representativeness are reported in Tarrant *et al.* (2010a). Briefly, from June 2004 to October 2006 this prospective observational study involved the recruitment of 539 pregnant women  $\geq 24$  weeks gestational age from separate public and private/semi-private antenatal clinics in the Coombe Women and Infants University Hospital (CWIUH), a maternity hospital which reported the highest number of mothers who delivered infants weighing  $> 500$  g from the three Dublin maternity hospitals in 2006 ( $n=8084$ ). From the 539 women recruited who were eligible to partake, 491 women (91%) agreed to participate and gave signed consent. Following application of exclusion criteria, 450 mother-infant pairs were subsequently followed up at 6 weeks and 6 months postpartum. This final sample ( $n=450$ ) represents 5.7, 5.8 and 5.6% of the total number of mothers who delivered infants weighing  $> 500$  g in the CWIUH in west Dublin during the years 2004, 2005 and 2006, respectively (Coombe Women and Infants University Hospital, 2006). Ethical approval was granted by the Ethical Committees of the CWIUH and Dublin Institute of Technology.

### *Data collection*

Following consent to study participation, mothers completed the first patient-administered questionnaire while waiting in antenatal clinics, and on the same day returned the questionnaire to the investigator. Data were collected on maternal education level, occupation, age, marital status, parity and whether the pregnancy was planned or unplanned (Tarrant, 2008). Mothers reported on their height and pre-pregnancy weight measurement, from which body mass index was computed (weight (kg)/height (m<sup>2</sup>)), and classified according to World Health Organisation (2003) definitions. All patient-administered questionnaires were checked by the investigator with mothers present, to ensure completeness of the data and to clarify any ambiguities.

Women were asked to state whether they (1) discontinued cigarette smoking upon recognition of pregnancy, were (2) non-smokers pre- and during pregnancy or (3) current smokers during pregnancy, in which case data were collected on the number of cigarettes smoked/day both pre- and during pregnancy. 'Non-smokers during pregnancy' refers to the women who were non-smokers pre- and during pregnancy, as well as those who discontinued smoking upon recognition of pregnancy. Data on mothers' alcohol consumption status during pregnancy were also recorded, including the number of alcohol units consumed/week both pre- and during pregnancy and the specific type of alcohol drink (wine, beer/stout, alcopop drinks and measure of spirits) consumed/unit.

Women were questioned on peri-conceptional FA supplement use, and data were elicited on the brand/type of FA supplement taken per day, as well as the timing of commencement. As neural tube closure occurs between 22 and 28 days postconception (Ray *et al.*, 2004), maternal uptake of FA 'at the recommended time peri-conceptionally' in the present study was defined as commencing FA supplementation at recommended doses  $\geq 400$  µg/day or at lower doses  $\geq 200$  µg/day, either preconceptionally or during the first month postconception. Women who reported taking a FA supplement and recorded the timing of commencement, but did not report the daily dose or brand consumed, were included in all analyses. Lack of compliance with peri-conceptional FA supplementation at the recommended time includes the women who took FA supplements  $> 1$  month postconception, as well as those who did not take any supplemental FA.

While the study participants were completing the antenatal patient-administered questionnaire in clinic, information on maternal/paternal country of birth and race, as well as a record of whether FA was taken pre or postconceptionally was collected by the investigator from the mother's medical notes. Any ambiguities between maternal recordings of the timing of FA uptake vs the data collected from the medical notes were clarified at the time. The infants' medical notes provided data on gender, type of delivery, gestational age and health status of infants at birth, as well as birth

weight (kg), length (cm) and head circumference (cm) measurements. Infant feeding factors related to breastfeeding and weaning onto solid foods, as previously reported (Tarrant *et al.*, 2010a, b), were collected from the 6-week and 6-month interviewer-administered questionnaires.

#### Statistical analyses

The analyses were performed using the Statistical Package for the Social Sciences (version 17; SPSS Inc., Chicago, IL, USA). Categorical data were compared using the  $\chi^2$  statistics test or Fisher's exact test, and significance levels were set at  $P < 0.05$ . For continuous normally distributed data, independent *t*-tests and one-way analysis of variance were performed. Wilcoxon signed-rank tests were used for non-normally distributed data. Continuous variables are summarised using mean values  $\pm$  s.d. or medians with interquartile ranges, as appropriate.

Three separate logistic regression analyses were performed to determine the factors associated with the dependent variables: (1) alcohol consumption, (2) maternal cigarette smoking during pregnancy, as well as (3) non-compliance with peri-conceptual FA supplementation at the recommended time/no FA. First, within each category a univariate analysis was performed to identify the significant ( $P < 0.05$ ) independent variables for inclusion in the subsequent multiple forward stepwise logistic regression analyses. The significant variables identified in the univariate analysis were then entered singly into the regression model, and were retained if statistical significance at  $P < 0.05$  criterion was achieved. Final models are presented using adjusted odds ratios (aORs) with their 95% confidence intervals (CIs).

## Results

#### Sample characteristics

Complete data were available for 450 mother-term infant pairs. The median age of participating women at antenatal recruitment, and hence, the timing of completion and return of patient-administered questionnaires to the investigator, was 36 weeks (interquartile range 32–39 weeks). Table 1 summarises the characteristics of the total sample, including those of the Irish national ( $n = 401$ ) and non-Irish national ( $n = 49$ ) mothers.

Irish national, compared with non-Irish national mothers, were significantly more likely to smoke (23.2 vs 2%,  $P = 0.000$ ) and consume alcohol (37.9 vs 14.3%,  $P = 0.002$ ) during pregnancy, however, equal proportions of mothers in both populations complied with peri-conceptual FA supplementation at the recommended time (44.6 vs 42.9%,  $P = 0.933$ ). Although differences in maternal social class were found between the two populations ( $P = 0.003$ ), no significant differences were observed in maternal age, education and pre-pregnancy body mass index, marital status, planned/unplanned pregnancy, infant birth weights, gender or parity.

#### Compliance with public health recommendations

As shown in Table 2, a combined 109 women (24.2%) complied with all three public health recommendations to avoid smoking and alcohol consumption during pregnancy, and commence supplemental FA at the recommended time. Complete non-compliance with all of these recommendations was found in 28 women (6.2%) in our sample.

A strong social class gradient was found between smoking during pregnancy as well as lack of compliance with peri-conceptual FA supplementation at the recommended time/no FA (Table 3), with a significantly higher prevalence of these health behaviours observed among mothers from lower social classes. No association was found between alcohol consumption during pregnancy and maternal social class with a similar proportion of mothers in social class I found to consume alcohol during pregnancy (40.7%) as those in social class III (40.8%).

#### Smoking during pregnancy

During pregnancy, 94 (20.9%) women smoked, 295 (65.5%) women were non-smokers and 61 (13.6%) women discontinued smoking upon recognition of pregnancy. In 77/94 smokers (82%) during pregnancy, the number of cigarettes smoked/day decreased significantly from a mean of 19.8 (s.d. 8.6) cigarettes smoked/day pre-pregnancy to 11.7 (s.d. 7.5) cigarettes smoked/day during pregnancy ( $P = 0.000$ ). No change in maternal cigarette smoking behaviour was observed in 10 of the smokers (10.6%) during pregnancy, while 7 women (7.4%) increased the number of cigarettes smoked/day from pre- to during pregnancy.

Logistic regression analysis showed that the risk of maternal cigarette smoking during pregnancy was associated with single, multiparous mothers, aged  $< 25$  years who delivered infants with a birth weight  $< 3$  kg, and those who did not initiate breastfeeding postpartum (Table 4). Irish nationality was positively associated with smoking during pregnancy (OR: 10.92, 95% CI: 1.35–87.98).

In addition, mothers who smoked  $> 10$  cigarettes/day ( $n = 32$ ) delivered infants with significantly lower mean infant birth weights (3.11 kg (s.d. 0.52) vs 3.66 kg (s.d. 0.5),  $P = 0.000$ ) and birth head circumference measurements (34.25 cm (s.d. 1.6) vs 35.33 cm (s.d. 1.37),  $P = 0.001$ ) than mothers who never smoked at all pre/during pregnancy ( $n = 295$ ).

#### Alcohol consumption during pregnancy

In 144/159 (90.5%) of the alcohol consumers during pregnancy, a decreased weekly alcohol consumption from pre-pregnancy (mean 7.13 (s.d. 5.58) alcohol units/week) to during pregnancy (mean 2.45 (s.d. 2.08) alcohol units/week) ( $P = 0.000$ ) was observed. An increase in weekly alcohol consumption from pre- to during pregnancy was found in two women (1.2%) in this sample, while no change in alcohol consumption intake was found in 13 women (8%).

**Table 1** Selected maternal socio-demographic, infant and postnatal infant feeding characteristics of the total sample, and by nationality

Characteristic	Total sample (n = 450) n (%)	Irish national mothers (n = 401) n (%)	Non-Irish national mothers (n = 49) n (%)	P-value
Maternal social class (based on occupation) <sup>a</sup>				
Social class I	140 (31.1)	124 (30.9)	16 (32.7)	0.003
Social class II	128 (28.4)	123 (30.7)	5 (10.2)	
Social class III	49 (10.9)	46 (11.5)	3 (6.1)	
Unknown category (unemployed/students)	57 (12.7)	46 (11.5)	11 (22.4)	
Stay-at-home mothers'/home-makers'	76 (16.7)	62 (15.5)	14 (28.6)	
Maternal age (years)				
> 34	85 (18.9)	73 (18.2)	12 (24.5)	0.436
25–34	267 (59.3)	238 (59.4)	29 (59.2)	
< 25	98 (21.8)	90 (22.4)	8 (16.3)	
Highest maternal education qualification				
Primary/secondary	177 (39.3)	160 (39.9)	17 (34.7)	0.076
Vocational/training course	124 (27.6)	115 (28.7)	9 (18.4)	
Third level degree/postgraduate level	149 (33.1)	126 (31.4)	23 (46.9)	
Pre-pregnancy BMI (kg/m <sup>2</sup> ) <sup>b</sup>				
< 20	47 (10.4)	41 (10.2)	6 (12.2)	0.860
20–24.9	253 (56.2)	225 (56.1)	28 (57.1)	
≥ 25	150 (33.3)	135 (33.7)	15 (30.6)	
Marital status				
Married/cohabitating	407 (90.4)	359 (89.5)	48 (98)	0.069
Single	43 (9.6)	42 (10.5)	1 (2)	
Parity				
Primiparous	213 (47.3)	196 (48.9)	17 (34.7)	0.084
Multiparous	237 (52.7)	205 (51.1)	32 (65.3)	
Planned current pregnancy				
Yes	282 (62.7)	250 (62.3)	32 (65.3)	0.804
No	168 (37.3)	151 (37.7)	17 (34.7)	
Smoking during pregnancy				
Yes	94 (20.9)	93 (23.2)	1 (2)	0.000
No	356 (79.1)	308 (76.8)	48 (98)	
Alcohol consumption during pregnancy				
Yes	159 (35.3)	152 (37.9)	7 (14.3)	0.002
No	291 (64.7)	249 (62.1)	42 (85.7)	
Folic acid supplement use at the recommended time				
Yes <sup>c</sup>	200 (44.4)	179 (44.6)	21 (42.9)	0.933
No <sup>d</sup>	250 (55.5)	222 (55.4)	28 (57.1)	
Birth weight (kg)				
< 3	65 (14.4)	58 (14.5)	7 (14.3)	0.781
3–4	309 (68.7)	277 (69.1)	32 (65.3)	
> 4	76 (16.9)	66 (16.5)	10 (20.4)	
Gender of infant				
Male	250 (55.6)	223 (55.6)	27 (55.1)	1.000
Female	200 (44.4)	178 (44.4)	22 (44.9)	
Initiated breastfeeding postpartum <sup>e</sup>				
Yes	228 (50.7)	189 (47.1)	39 (79.6)	0.000
No	222 (49.3)	212 (52.9)	10 (20.4)	

Abbreviation: BMI, body mass index.

Results are expressed as number of subjects and percentage.

Significant differences (*P*-values) between Irish national and non-Irish national mothers using cross tabulations and  $\chi^2$  statistics test or Fisher's exact test in cases where one or more of the cells has a frequency of 5 or less; the Yates's continuity correction value was used for all 2 × 2 tables.<sup>a</sup>Maternal occupations were categorised according to the social class categories from the UK (Office of Population Census and Surveys, 1991) and Irish (Central Statistics Office Census, 1996) classification system; a separate category was created for those who reported that they were 'stay-at-home mothers'.<sup>b</sup>BMI categories are in accordance with World Health Organisation (2003) definitions (<20 kg/m<sup>2</sup>, underweight; 20–24.9 kg/m<sup>2</sup>, normal weight; ≥25 kg/m<sup>2</sup>, overweight). BMI values were derived from mothers' self-reported pre-pregnancy weight and height.<sup>c</sup>Includes women who commenced folic acid supplementation at the recommended time, i.e., either preconception (*n* = 181) or during the first month postconception (*n* = 19), at doses 350–400 µg/day.<sup>d</sup>Includes women who did not commence folic acid supplementation at the recommended time, i.e., > 1 month post conception (*n* = 195); these women were categorised with the women who did not take any folic acid supplementation at all (*n* = 55).<sup>e</sup>Breastfeeding initiation was defined as all mothers who 'ever tried to breastfeed' postpartum.

Wine and beer/stout were the most frequently consumed alcoholic drinks by 94 and 59 mothers, respectively, followed by alcopop drinks ( $n=15$ ) and spirits ( $n=4$ ).

In both the univariate and logistic regression analyses, breastfeeding initiation and nationality were the only two variables that were significantly associated with alcohol consumption during pregnancy; notably, Irish nationality

was identified as an independent predictor of alcohol consumption during pregnancy (OR: 4.37, CI: 1.88–10.15) (Table 5).

**Table 2** Compliance with public health recommendations in a sample of pregnant women in Dublin ( $n=450$ )

Compliance rating	Did not smoke	Did not consume alcohol	Complied with folic acid supplementation at the recommended time <sup>a</sup>	n (%)
0 <sup>b</sup>	No	No	No	28 (6.2)
1 <sup>c</sup>	No	No	Yes	7 (1.5)
1 <sup>c</sup>	No	Yes	No	48 (10.6)
1 <sup>c</sup>	Yes	No	No	51 (11.3)
2 <sup>d</sup>	No	Yes	Yes	11 (2.4)
2 <sup>d</sup>	Yes	No	Yes	73 (16.2)
2 <sup>d</sup>	Yes	Yes	No	123 (27.3)
3 <sup>e</sup>	Yes	Yes	Yes	109 (24.2)

Results are expressed as number of subjects and percentage.

<sup>a</sup>Includes women who complied with folic acid supplementation at the recommended time, i.e., either preconception ( $n=181$ ) or during the first month postconception ( $n=19$ ), at doses 350–400 µg/day.

<sup>b</sup>Compliance rating of 0 indicates complete non-compliance with all three public health recommendations.

<sup>c</sup>Compliance rating of 1 indicates compliance with one public health recommendation and non-compliance with two recommendations.

<sup>d</sup>Compliance rating of 2 indicates compliance with two public health recommendations and non-compliance with one recommendation.

<sup>e</sup>A compliance rating of 3 indicates complete compliance with all three public health recommendations.

#### Peri-conceptual FA supplementation

In all, 395 (87.7%) women reported taking a daily FA supplement during pregnancy, including *Clonfolic* (Clonmel Healthcare Limited, Tipperary, Republic of Ireland) 400 µg FA/day ( $n=315$ ), *Galfer* FA (Thornton and Ross Limited, Linthwaite Labs, Huddersfield, UK) 350 µg FA/day ( $n=21$ ) and *Pregnacare* (Vitabiotics Limited, London, UK) 400 µg FA/day ( $n=12$ ), while 47 women reported to not knowing the brand name or dose of the FA supplement consumed. Commencement of peri-conceptual FA supplementation at the 'recommended time' was reported in 200 (44.4%) women, including 181 preconceptionally ( $n=39$ , 1 month;  $n=28$ , 2 months;  $n=49$ , 3 months;  $n=35$ , 6 months;  $n=30$ , >6 months preconception) and 19 women during the first month postconception. Among these women who reported taking supplemental FA at the recommended time, the brand and daily dosage of the supplements consumed included: *Clonfolic* 400 µg FA/day ( $n=160$ ), *Pregnacare* 400 µg FA/day ( $n=9$ ), *Galfer* FA 350 µg FA/day ( $n=5$ ) while the dose and brand of supplemental FA consumed was unknown in 26 of cases. FA supplements were consumed by 160 women during the second month of pregnancy, and 35 women during the third month of pregnancy, while 55 (12.2%) women reported to not consuming any supplemental peri-conceptual FA.

After adjustment, factors positively associated with non-compliance with peri-conceptual FA supplementation at

**Table 3** Maternal health behaviours during pregnancy, by maternal social class<sup>a</sup> ( $n=450$ )

Maternal health behaviour	Social class I n (%)	Social class II n (%)	Social class III n (%)	Unknown category (unemployed/students) n (%)	Stay-at-home mothers'/' home-makers' n (%)	P-value
<i>Smoking during pregnancy</i>						
Yes	13 (9.3)	19 (14.8)	12 (24.5)	20 (35.1)	30 (39.5)	0.000
No	127 (90.7)	109 (85.2)	37 (75.5)	37 (64.9)	46 (60.5)	
<i>Alcohol consumption during pregnancy</i>						
Yes	57 (40.7)	43 (33.6)	20 (40.8)	16 (28.1)	23 (30.3)	0.313
No	83 (59.3)	85 (66.4)	29 (59.2)	41 (71.9)	53 (69.7)	
<i>Folic acid supplement use at the recommended time</i>						
Yes <sup>b</sup>	85 (60.7)	69 (53.9)	13 (26.5)	7 (12.3)	26 (34.2)	0.000
No <sup>c</sup>	55 (39.3)	59 (46.1)	36 (73.5)	50 (87.7)	50 (65.8)	

Differences between social class category and maternal health behaviours were examined using cross tabulations and  $\chi^2$  statistics test; *P*-values indicate the significant differences between these groups.

<sup>a</sup>Maternal social class was categorised according to mothers' occupation. Social class categories from the UK (Office of Population Census and Surveys, 1991) and Irish (Central Statistics Office Census, 1996) classification system were used with a separate category created for mothers who were 'stay-at-home' mothers.

<sup>b</sup>Women who commenced folic acid supplementation at the recommended time, i.e., either preconception ( $n=181$ ) or during the first month postconception ( $n=19$ ), at doses 350–400 µg/day.

<sup>c</sup>Women who did not commence folic acid supplementation at the recommended time, i.e., >1 month postconception ( $n=195$ ); these women were categorised with the women who did not take any folic acid supplementation at all ( $n=55$ ).



**Table 4** Factors associated with smoking during pregnancy in a sample of women in Dublin ( $n=450$ )

Characteristic	Non-smokers, n (%)	Smokers, n (%)	P-value <sup>a</sup>	OR <sup>b</sup> (95% CI)	Adjusted OR <sup>c</sup> (95% CI)	P-value <sup>d</sup>
<i>Maternal age (years)</i>						
> 34	76 (89.4)	9 (10.6)		1.0 <sup>e</sup>	1.0	
25–34	221 (82.8)	46 (17.2)		1.75 (0.82–3.76)	1.46 (0.61–3.48)	
< 25	59 (60.2)	39 (39.8)	0.000	5.58 (2.5–14.43)	3.56 (1.32–9.57)	0.011
<i>Highest maternal education qualification</i>						
Third level degree/postgraduate	139 (93.3)	10 (6.7)		1.0	1.0	
Vocational/training course	98 (79)	26 (21)		3.68 (1.7–7.99)	1.78 (0.74–4.26)	
Primary/secondary	119 (67.2)	58 (32.8)	0.000	6.77 (3.31–13.84)	2.58 (1.14–5.84)	0.065
<i>Nationality</i>						
Non-Irish national	48 (98)	1 (2)		1.0	1.0	
Irish national	308 (76.8)	93 (23.2)	0.001	14.49 (1.9–106.4)	10.92 (1.35–87.98)	0.025
<i>Marital status</i>						
Married/cohabitating	338 (83)	69 (17)		1.0	1.0	
Single	18 (41.9)	25 (58.1)	0.000	6.8 (3.5–13.1)	2.93 (1.37–6.27)	0.005
<i>Parity</i>						
Primiparous	178 (83.6)	35 (16.4)		1.0	1.0	
Multiparous	178 (75.1)	59 (24.9)	0.037	1.68 (1.05–2.68)	2.31 (1.25–4.26)	0.008
<i>Birth weight (kg)</i>						
> 4	71 (93.4)	5 (6.6)		1.0	1.0	
3–4	250 (80.9)	59 (19.1)		3.35 (1.29–8.66)	2.36 (0.85–6.4)	
< 3	35 (53.8)	30 (46.2)	0.000	12.17 (4.34–34)	7.83 (2.57–23.77)	0.000
<i>Initiated breastfeeding postpartum<sup>f</sup></i>						
Yes	212 (93)	16 (7)		1.0	1.0	
No	144 (64.9)	78 (35.1)	0.000	7.17 (4.02–12.79)	3.04 (1.59–5.82)	0.001

Abbreviations: CI, confidence interval; OR, odds ratio.

Results are expressed as number of subjects and percentage.

<sup>a</sup>Statistical analysis by  $\chi^2$  statistics test. The Yates's continuity correction value was used for all  $2 \times 2$  tables.<sup>b</sup>Unadjusted OR from logistic regression analysis.<sup>c</sup>OR adjusted for all other variables in the table using logistic regression analysis.<sup>d</sup>P-value from adjusted logistic regression model.<sup>e</sup>1.0 denotes the reference category.<sup>f</sup>Breastfeeding initiation was defined as all mothers who 'ever tried to breastfeed' postpartum.

the recommended time/no FA, included maternal cigarette smoking during pregnancy, maternal age <25 years, pre-pregnancy body mass index <20 kg/m<sup>2</sup> and addition of non-recommended condiments (for example, gravy and sauces) to infants' weaning foods (Table 6). In particular, logistic regression analysis indicated that mothers who reported an unplanned pregnancy were significantly more likely to have not taken supplemental FA at the recommended time/at all (OR: 13.24, 95% CI: 7–24.7).

## Discussion

Only 24.2% of mothers complied with the public health recommendations to commence peri-conceptual FA supplementation at the recommended time, avoid smoking and completely abstain from alcohol consumption during pregnancy. The fact that 6.2% of mothers did not comply with any of these recommendations highlights the potential health disparities and increased likelihood for a compro-

mised pregnancy outcome within our sample of mothers (Cnattingius, 2004; Busby *et al.*, 2005).

Essentially, over half of the mothers in this study (55.5%) did not achieve optimal protection against NTDs. This finding is of major clinical importance owing to evidence that increased peri-conceptual intakes of FA can significantly reduce the risk of first occurrence (Czeizel and Dudas, 1992) and recurrence (MRC, 1991) of NTDs in up to 72% of cases. The fact that Irish NTD rates are among the highest in Europe, affecting 1–1.5 per 1000 total births nationally, and that NTDs account for more national perinatal deaths than any other group of birth defects (Food Safety Authority of Ireland, 2006) further increases the importance of strict compliance with daily peri-conceptual FA supplementation among women who could possibly conceive in Ireland. Although voluntary fortification of foodstuffs with FA has led to a higher folate status in the Irish population, current or future mandatory fortification is not recommended (Food Safety Authority of Ireland, 2008); thus, there is increased maternal reliance on supplemental FA to achieve optimal

**Table 5** Factors associated with alcohol consumption during pregnancy in a sample of women in Dublin ( $n=450$ )

Characteristic	Non-alcohol consumers, n (%)	Alcohol consumers, n (%)	P-value <sup>a</sup>	OR (95% CI) <sup>b</sup>	Adjusted OR <sup>c</sup> (95% CI)	P-value <sup>d</sup>
<i>Maternal age (years)</i>						
> 34	48 (56.5)	37 (43.5)		1.0 <sup>e</sup>	1.0	
25–34	175 (65.5)	92 (34.5)		0.68 (0.41–1.12)	0.7 (0.41–1.17)	
<25	68 (69.4)	30 (30.6)	0.170	0.57 (0.31–1.05)	0.59 (0.31–1.15)	0.268
<i>Highest maternal education qualification</i>						
Third level degree/postgraduate	99 (66.4)	50 (33.6)		1.0	1.0	
Vocational/training course	71 (57.3)	53 (42.7)		1.47 (0.9–2.41)	1.63 (0.96–2.75)	
Primary/secondary	121 (68.4)	56 (31.6)	0.120	0.91 (0.57–1.45)	1.17 (0.69–1.99)	0.166
<i>Nationality</i>						
Non-Irish national	42 (85.7)	7 (14.3)		1.0	1.0	
Irish national	249 (62.1)	152 (37.9)	0.002	3.66 (1.6–8.35)	4.37(1.88–10.15)	0.001
<i>Initiated breastfeeding postpartum<sup>f</sup></i>						
No	155 (69.8)	67 (30.2)		1.0	1.0	
Yes	136 (59.6)	92 (40.4)	0.031	1.56 (1.06–2.31)	1.78 (1.15–2.76)	0.010

Abbreviations: CI, confidence interval; OR, odds ratio.

Results are expressed as number of subjects and percentage.

<sup>a</sup>Statistical analysis by  $\chi^2$  statistics test. The Yates's continuity correction value was used for all  $2 \times 2$  tables.<sup>b</sup>Unadjusted OR from logistic regression analysis.<sup>c</sup>OR adjusted for all other variables in the table using logistic regression analysis.<sup>d</sup>P-value from adjusted logistic regression model.<sup>e</sup>1.0 denotes the reference category.<sup>f</sup>Breastfeeding initiation was defined as all mothers who 'ever tried to breastfeed' postpartum.

protection against NTDs. However, the rate of compliance with peri-conceptual FA supplementation at the recommended time in the present study (44.4%) is higher than what has been found in other Dublin-based studies, including 24% (Ward *et al.*, 2004) and 28% (McGuire *et al.*, 2010), suggesting an improved awareness of the importance of peri-conceptual FA supplementation in our sample of mothers. Suboptimal peri-conceptual FA supplementation rates are not just a concern in Ireland, but globally, with rates of 10.3 and 52% reported in Korea (Kim *et al.*, 2009) and the Netherlands (Bekkers and Eskes, 1999), respectively.

In agreement with the literature (Brough *et al.*, 2009; Kim *et al.*, 2009; McGuire *et al.*, 2010), mothers from lower social classes and those who reported an unplanned pregnancy were the least likely to comply with peri-conceptual FA supplementation at the recommended time/or take no FA. To increase peri-conceptual FA uptake, our data indicate that promotional campaigns should target younger women <25 years, smokers, those from lower socio-economic groups and, in particular, women not planning pregnancies. Public health strategies that raise awareness of the peri-conceptual timeframe for optimal NTD protection, among all women of childbearing age, should also be considered.

Previous Irish studies report considerably higher alcohol consumption during pregnancy rates of 78% (Daly *et al.*, 1992) and 89% (McMillan *et al.*, 2006) than those found in the present study (35.3%). Although we found that the vast majority of alcohol consumers decreased their weekly

alcohol intake during pregnancy (90.5%), it appears that more effective public health approaches are required to persuade pregnant women to completely abstain from alcohol consumption. Pre-pregnancy and antenatal advice to women should include the fact that alcohol is a potent teratogen, and consumption during pregnancy can cause a spectrum of malformations and neurological, cognitive and behavioural deficits that are fully preventable (Landgren *et al.*, 2010).

No association between alcohol consumption during pregnancy and social class was observed in our study, with mothers in social class I (40.7%) being as likely to consume alcohol as those in social class III (40.8%). The fact that maternal age and education level were not associated with alcohol consumption during pregnancy, and that the alcohol consumers compared with the non-alcohol consumers were more likely to initiate breastfeeding postpartum further indicates a lack of any socio-demographic disparity as regard alcohol consumption during pregnancy in our sample of mothers. The finding that Irish national, compared with non-Irish national mothers were significantly more likely to consume alcohol during pregnancy is consistent with a recent Irish study (Barry *et al.*, 2007), which similarly found a higher prevalence of alcohol consumption among Irish national (79%) compared with non-European Union mothers (26%).

Just over one fifth of mothers (20.9%) smoked during pregnancy in this study, indicating some improvement from



**Table 6** Factors associated with non-compliance with peri-conceptual folic acid supplementation at the recommended time/no folic acid in a sample of women in Dublin (*n* = 450)

Characteristic	Peri-conceptual FA at RT, <i>n</i> (%)	Non-compliance with FA at RT, <i>n</i> (%)	P-value <sup>a</sup>	OR <sup>b</sup> (95% CI)	Adjusted OR <sup>c</sup> (95% CI)	P-value <sup>d</sup>
<i>Maternal age (years)</i>						
> 34	54 (63.5)	31 (36.5)		1.0 <sup>e</sup>	1.0	
25–34	134 (50.2)	133 (49.8)		1.72 (1.04–2.85)	1.31 (0.72–2.39)	
< 25	12 (12.2)	86 (87.8)	0.000	12.48 (5.9–26.38)	4.0 (1.64–9.77)	0.007
<i>Highest maternal education qualification</i>						
Third level degree/postgraduate	85 (57)	64 (43)		1.0	1.0	
Vocational/training course	63 (50.8)	61 (49.2)		1.28 (0.79–2.07)	0.78 (0.43–1.44)	
Primary/secondary	52 (29.4)	125 (70.6)	0.000	3.19 (2.01–5.04)	1.3 (0.72–2.35)	0.266
<i>Planned current pregnancy</i>						
Yes	186 (66)	96 (34)		1.0	1.0	
No	14 (8.3)	154 (91.7)	0.000	21.3(11.69–38.8)	13.24 (7–24.7)	0.000
<i>Smoking during pregnancy</i>						
No	182 (51.1)	174 (48.9)		1.0	1.0	
Yes	18 (19.1)	76 (80.9)	0.000	4.41 (2.53–7.68)	2.26 (1.13–4.52)	0.020
<i>Pre-pregnancy BMI (kg/m<sup>2</sup>)<sup>f</sup></i>						
≥ 25	61 (40.7)	89 (59.3)		1.0	1.0	
20–24.9	130 (51.4)	123 (48.6)		0.64 (0.43–0.97)	0.74 (0.44–1.23)	
< 20	9 (19.1)	38 (80.9)	0.000	2.89 (1.3–6.41)	2.35 (0.87–6.28)	0.044
<i>Added non-recommended condiments to infants' foods<sup>g</sup></i>						
No	159 (52.6)	143 (47.4)		1.0	1.0	
Yes	40 (27.2)	107 (72.8)	0.000	2.97 (1.93–4.56)	1.82 (1.05–3.13)	0.030

Abbreviations: BMI, body mass index; CI, confidence interval; FA, folic acid; OR, odds ratio; RT, recommended time.

Results are expressed as number of subjects and percentage.

<sup>a</sup>Statistical analysis by  $\chi^2$  statistics test. The Yates's continuity correction value was used for all 2 × 2 tables.<sup>b</sup>Unadjusted OR from logistic regression analysis.<sup>c</sup>OR adjusted for all other variables in the table using logistic regression analysis.<sup>d</sup>P-value from adjusted logistic regression model.<sup>e</sup>1.0 denotes the reference category.<sup>f</sup>BMI categories are in accordance with World Health Organisation (2003) definitions (<20 kg/m<sup>2</sup>, underweight; 20–24.9 kg/m<sup>2</sup>, normal weight; ≥25 kg/m<sup>2</sup>, overweight). BMI values were derived from mothers' self-reported pre-pregnancy weight and height.<sup>g</sup>Includes mothers who added non-recommended condiments to their infants' weaning foods (*n* = 449), including ordinary gravy, butter, sauces, vegetable stock, salt and sugar/honey.

rates of 29% (Walsh *et al.*, 2007) and 27.9% (Donnelly *et al.*, 2008) reported in previous Irish studies. Maternal cigarette smoking during pregnancy is a well-documented international concern with rates from 10.1% in Switzerland (Lemola and Grob, 2007) to 29.5% in the USA (McFarlane *et al.*, 1996) reported. Consistent with our findings (Abrahamsson and Ejertsson, 2000; Hensley Alford *et al.*, 2009), multiparous, younger women <25 years from lower social classes were identified as high-risk groups for smoking continuation during pregnancy. Lower maternal education level has been shown to be an important determinant of smoking during pregnancy in other studies (Ebrahim *et al.*, 2000; Gilman *et al.*, 2008); however, a stronger association between smoking in pregnancy and younger maternal age (<25 years) was indicated in the present study. To our knowledge, smoking behaviours by nationality has not been previously studied in Ireland. While Irish nationality was identified as a positive predictor of alcohol consumption during pregnancy, we also identified Irish nationality as

being an independent predictor of maternal cigarette smoking during pregnancy. As smoking during pregnancy is associated with approximately one third of low birth weight, one quarter of small for gestational age and one sixth of preterm births (Delpisheh *et al.*, 2007) and that 1% of all children are given a suboptimal introduction to life owing to their mother's smoking habits during pregnancy (Kallen, 2001), interventions and smoking cessation programmes that target these high-risk groups would be a worthwhile public health investment for Ireland.

A significant decrease in the number of cigarettes smoked per day and in the number of alcohol units consumed per week was found among the smokers and alcohol consumers, respectively, from pre- to during pregnancy in our study. In addition, a higher compliance rate with daily supplemental FA use was reported during pregnancy (*n* = 395; 87.7%) than preconceptionally (*n* = 181; 40.2%). Such trends towards improved compliance with public health recommendations in pregnancy have also been reported by other investigators

(Crozier *et al.*, 2009). Taken together, these data provide encouraging evidence that change in behaviour is possible for women, with a major behavioural change motivator likely to be a desire for the best possible pregnancy and infant health outcome. However, low compliance rates with public health recommendations concerning alcohol, smoking and FA use have also been reported in non-pregnant women during the months before becoming pregnant. Inskip *et al.* (2009) reports that only 2.9% of women complied fully with the recommendations on alcohol ( $\leq 4$  units of alcohol/week) and FA intakes ( $\geq 400 \mu\text{g/day}$ ) in 3 months before becoming pregnant, while only 44% of women reported taking any supplemental FA. The possibility that pre-pregnancy recommendations are not publicised widely enough must be considered. Given the high rate of unplanned pregnancies reported in national and international literature, greater public health efforts are needed to improve compliance with nutrition and lifestyle recommendations in women of childbearing age across the socio-demographic spectrum.

This study has a number of limitations. First, as this was a single-sited prospective study capturing the health behaviours of a convenience sample of women in west Dublin, the prevalence of health behaviours under study and the factors affecting mothers in our sample may differ across the island of Ireland. Second, owing to social desirability, it is known that some women may overestimate their compliance with public health recommendations during pregnancy (Ford *et al.*, 1997), which may have led, somewhat, to a potential inaccurate estimation of the actual prevalence rates reported. Such over/underestimations are, however, unlikely to differ from other similarly designed studies. Third, mothers' retrospective recollection of the timing of periconceptional FA supplementation might be at risk of recall bias. However, collection of the timing of FA uptake from the mothers' medical notes and clarification of any ambiguities that may have arisen may have increased the accuracy of these data. Finally, several factors that have been reported as predictors of maternal health behaviours, including the smoking behaviours of the partner and maternal grandmother (Lemola and Grob, 2008), were not collected in this study, which may somewhat limit interpretation of the multivariate analyses.

In conclusion, our data indicate that a large proportion of women in Ireland, in particular women of Irish nationality, continue to smoke and consume alcohol during pregnancy. Suboptimal compliance with peri-conceptional FA supplementation was a particular concern in this study with less than half of the sample potentially achieving optimal protection against NTDs. To decrease health inequalities in Ireland, our data suggest that lower socio-economic groups and younger women <25 years should be specifically targeted in smoking cessation and FA promotion campaigns. In addition, more effective public health approaches are required to convince, in particular, Irish national women from all socio-economic groups, of the adverse fetal and

maternal health risks associated with alcohol consumption during pregnancy.

## Conflict of interest

The authors declare no conflict of interest.

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